THE NEED FOR HIGH VOLUME, PERSONAL BREATHING ZONE SAMPLING METHODS

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Sampling At Low Levels Can Be Challenging.

Many exposure limits are low:

Beryllium (NIC, inhalable)	0.02	ug/m^3
Gallium Arsenide (respirable)	0.3	ug/m^3
Strontium Chromate (as Cr)	0.5	ug/m^3
Calcium Chromate (as Cr)	1	ug/m^3
Natural Latex (inhalable)	1	ug/m^3
Cadmium (respirable)	2	ug/m^3
Hexachlorobenzene	2	ug/m^3

Exposure limits are likely to go lower.

This Is What We Need.

Tricorder

Proper hand position for elemental scanning as demonstrated by Mr. Spock.

- **Advantage:** Can measure almost anything, almost anywhere.
- **Drawback:** Will not be available until early 23rd century.

What To Do In The Meantime?

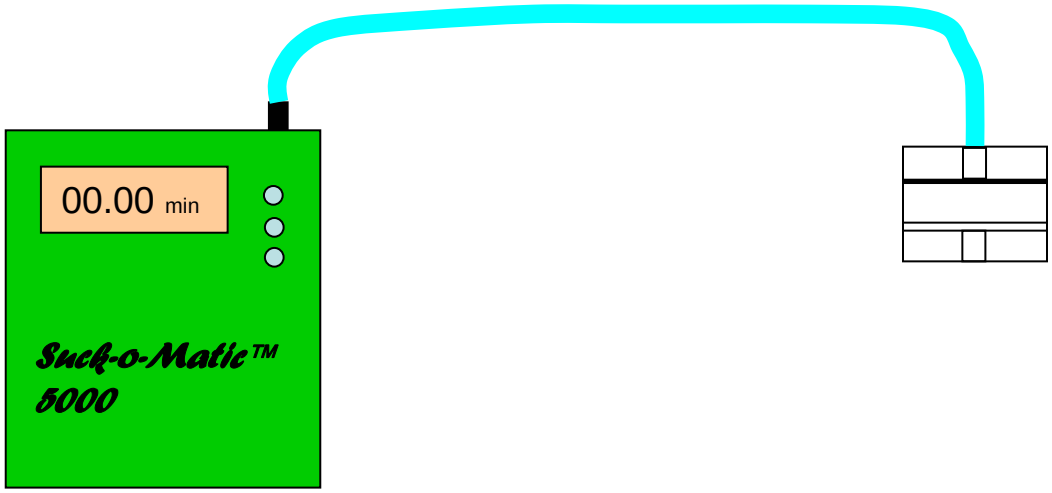
Improve analytical sensitivity:

- May already be near limit for many methods.
- Customers require consistent reporting.
- Significant equipment and facility requirements.
- Cost can be prohibitive.

Increase sample volume:

- Current samplers and pumps limit use.
- New equipment entering market.
- Better statistical power and mean estimate.
- May be the best short and intermediate term choice.

Basic Personal Air Sampling System



Pump

Adjustable flow.
Constant air flow.
Worker “wearable”.
Operates for full work shift.

Sampler

Efficiently collect particles.
Retain particles for analysis.
Known particle size cutoff.
Practical to use.

Sampling Pump – What Flow Rates Are Needed?

Flow rate required (liter/min) to collect a measurable sample at 0.2 ug/m^3 airborne beryllium.

Sampling Time, minutes.	Limit of Quantitation, ug/sample. 0.005	0.01	0.03	0.05
15	1.7	3.3	10	17
60	0.4	0.8	2.5	4.2
240	0.1	0.2	0.6	1.0
480	0.05	0.1	0.3	0.5

Sampling Pump – What Flow Rates Are Needed?

Flow rate required (liter/min) to collect a measurable sample at 0.02 ug/m^3 airborne beryllium.

Sampling Time, minutes.	Limit of Quantitation, ug/sample. 0.005	0.01	0.03	0.05
15	17	33	100	167
60	4.2	8.3	25	42
240	1.0	2.1	6.3	10
480	0.5	1.0	3.1	5.2

Sampling Pump – What Flow Rates Are Needed?

Flow rate required (liter/min) to collect a measurable sample at 0.004 ug/m^3 airborne beryllium.

Sampling Time, minutes.	Limit of Quantitation, ug/sample. 0.005	0.01	0.03	0.05
15	83	167	500	833
60	21	42	125	198
240	5.2	10	31	50
480	2.6	5.2	16	25

Sampling Pump – How to Get Needed Flow?

New Product:

- SKC Leland Legacy® pump.
- Measured Flows
  - ⇨ 7.5 liter/min with one 0.8 um 37 mm filter.
  - ⇨ 10 liter/min with two 0.8 um 37 mm filter.
- Concerns:
  - ⇨ physical size (8” high, 37 oz).
  - ⇨ back-pressure limits (20” wg at 7.5 liter/min).
  - ⇨ noise (without case, 78 dBA at ear).
  - ⇨ vibration (without case).

Other pumps available?

Sampling Pump – How to Get Needed Flow?

Using Your Current Equipment:

- Area sampling pump tethered to worker.
  - ⇨ Only practical if work is performed in a small area.
  - ⇨ Safety must be considered.
  - ⇨ Worker may be willing to carry battery powered pump between locations.
- Two standard sampling pumps connected in parallel.
  - ⇨ Each pump set to 4 liter/min.
  - ⇨ Connected to single 37 mm filter via a “Y” joint.
  - ⇨ One pump “tuned” to stabilize flow.
  - ⇨ Obtained flow of 7.4 liter/min. Stable over 1 hr; 1% drop.
  - ⇨ Potential pump damage? Maximum sampling time?

Sampling Pump – Research & Development Needs

Desired Features:

- Flow Rate: 10 to 15 liter/min with 0.8 um, 37 to 47 mm filter.
- Back Pressure: 25 inches water at 15 liter/min.
- Operating Time: Up to 10 hours.
- Weight: Less than 32 ounces.
- Size: 5” x 4” x 2” maximum.
- Noise Levels: Less than 70 dBA.
- Cost: less than $1000.
- Keep it simple, fast, and easy!

Sampling Pump – Possible Ideas

Design Possibilities:

- Battery pack a separate unit.
  - ⇨ Better weight distribution.
  - ⇨ Reduced package size.
  - ⇨ “Utility Belt” concept.
  - ⇨ Further reduce weight if changed at midday.
- Backpack design.

Possible Compromise:

- A “task sample” personal pump that will sample at 10 to 20 liter/min for up to 2 hours.

Sampler – What Is Available Now?

Standard 37 mm Cassette:

- Low cost, readily available.
- Simple to use, minimal preparation.
- 50% cutoff about 30 um at 2 liter/min.
- Particle cutoff not known at higher flows.
- Referred to as “Total” dust sampling. Does not meet any of the ACGIH particle size-selective criteria.

Sampler – What Is Available Now?

Inhalable Samplers:

7 Hole
2 liter/min

IOM
2 liter/min

GSP (CIS)
3.5 liter/min

Sampler – What Is Available Now?

Inhalable Samplers:

Button
4 liter/min

RespiCon
3.1 liter/min

Sampler – What Is Available Now?

PM Sampler:

PEM - Personal Environmental Monitor

- Designed to collect PM2.5 or PM10 fractions.
- Models for 2, 4, or 10 liter/min.
- Possible re-design for inhalable at 10 liter/min?

2.5 um, 2 liter/min

2.5 um, 10 liter/min

10 um, 4 liter/min

Sampler – Research & Development Needs

Desired Features:

- Material: Molded plastic (disposable).
- Simple to use, minimal preparation.
- Cost: less than $5.
- Weight: Less than 3 ounces.
- Size: 2” x 2” x 3” maximum.
- Known particle size collection at given flow.
- Available for ACGIH respirable, thoracic, and inhalable particle mass fractions.
- “Off the shelf” sampling. Designed for routine use.

Sampler – Possible Ideas

Design Possibilities:

- Base on standard 37mm cassette concept.
- Develop replaceable cassette face piece with openings designed for different particle size fractions and flow rates.
- 47mm filters may allow for higher flow rates without being too large for worker comfort.
- Sampler wall losses may be a concern. A totally digestible filter housing similar to the ACCU-CAP™ should be explored.

Summary

- It is essential to improve the sensitivity of sampling and analytical methods to meet demands placed by falling OELs.
- Improvements in analytical quantitation limits will help the situation, but may be limited by cost and technical constraints.
- Most needed is the equipment and methods for high volume personal breathing zone sampling.

Summary

- Both air pumps and samplers will need to be improved and/or developed.
- The methods must be relatively easy and low cost, otherwise routine sampling will not be performed at the desired frequency.
- High volume personal sampling methods will need validation by recognized agencies such as NIOSH, OSHA, or ASTM.

Sources for Illustrations and Product Data

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